

How Physical Amenities Relate to the Mental Well-being of Columbus Residents

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Introduction

The 2014 Gallup-Healthways Well-Being Index analyzed data concerning the well-being of individuals in every metropolitan statistical area of the U.S. to learn more about the nation's well-being. The "happiest" metropolitan areas tended to be those with low unemployment rates, low poverty rates, and warm climates. Unfortunately, Ohio had two cities ranked in the top ten "unhappiest" areas, one of which was Columbus, which ranked eighth from the bottom of the 2014 well-being study. Ohio has consistently had one of the ten lowest scores for statewide well-being since 2008 when the study began. Well-being is important because it is an indication of individuals' satisfaction with life and high life satisfaction encourages people to stay in communities and help them thrive. In addition, policy experts care about well-being because it is one of many ways to measure and understand the success and progress of a community.

Well-being is often described as having many components and these components are categorized differently depending on the field of study and the objective of the researcher (Layard, 2010). For instance, Völker and Kistemann (2011) describe well-being as a "a complex measurable subjective state of consciousness comprised of multiple distinct components." An important component of well-being is mental health. Research that either directly or indirectly addresses well-being commonly refers to this psychological aspect of well-being as "positive mental health" or, as it is referred to throughout this thesis, "mental well-being" (MWB) (Ruth et al., 2007).

Mental health is defined by the World Health Organization as “a state of well-being in which every individual realizes his or her own potential, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to her or his community” (WHO, 2014). Healthy, prosperous, and cooperative communities rely on mentally healthy residents because mental health determines the extent to which residents can successfully overcome challenges and contribute economically and socially to their community (Galson, 2009). A complex combination of lifestyle factors and circumstances affect emotional, spiritual, and intellectual well-being, or collectively, MWB (Corvalan et al., 2005). In this study, mental well-being is measured using five self-reported factors: spiritual health, happiness, enjoyment of leisure time, positivity, and life satisfaction.

The assessment of individual mental well-being is complex because many factors have been found to affect it. The effects of different life factors on MWB are difficult to measure and disentangle from each other (Diener and Suh, 2000). Some identified factors that affect well-being include income, race, gender, and type and state of government (2000). There are some specific factors that consistently show relationships with mental well-being; one with significant potential to affect MWB is the physical surroundings of an area (Jackson, 2003).

Promising research at the nexus of environmental psychology and urban planning has shown that well-being and physical surroundings are affected by each other (Lee and Maheswaran, 2010). Three aspects specifically, green space, blue space, and walkability may affect MWB. Green space is space in an urban area covered in grass, trees, or other

vegetation. Blue space refers to space that is covered by or in close proximity to rivers, lakes, ocean, or any other natural or manmade water features. Walkability is a measure of how feasible and comfortable it is to accomplish pedestrian activities in a neighborhood. Importantly, there is a growing amount of literature exploring the relationship between such urban environmental amenities and levels of mental distress (White et al., 2013; Karmanov and Hamel, 2008; Volker and Kistemann, 2011).

For instance, high-quality, accessible green and blue space may contribute to higher overall scores of communities' mental well-being (Karmanov and Hamel, 2008). A study on three communities in New Hampshire found that urban planning practices that lead to higher levels of walkability have implications for higher overall quality of life (Rogers et al., 2010). As more research is executed and published, especially in areas like the Midwest where minimal research has been done, planners may gain stronger justification when advocating for higher quality and quantity of these amenities in urban areas. This study aims to shed light on several questions related to environmental amenities and levels of mental well-being.

- 1) First, does the availability of green space (parks, cemeteries, golf courses) in one's neighborhood correlate with overall mental well-being or a specific measure of mental health (happiness)?
- 2) Does the availability of blue space in a neighborhood correlate with overall mental well-being of residents or a specific measure of mental health (happiness)?

- 3) How, if at all, does neighborhood walkability (measured as sidewalk length) relate to mental well-being?

Background

Both the natural and built environment have daily and significant effects on our mental state and behaviors (Jackson, 2003). Three aspects of neighborhood design that may affect MWB are green space, blue space and the walkability of the area.

The biophilia hypothesis, put forth by E.O. Wilson, suggests that interaction with the environment and its living components is fundamental to human well-being (Wilson, 1984). The author hypothesized that humans are predisposed to a love of living things and he teaches that physical, emotional, and physiological benefits accrue to individuals who have an appreciation for and connection to nature. Furthermore, a related hypothesis proposes that green space in urban areas can have significant effects on the mental well-being of people who live near it (Fuller et al., 2007).

In the field of city and regional planning, it is common for policy makers to regard green space as a luxury good, underestimating the hidden potential for green space to positively affect urban residents (Groenewegen et al., 2006). A meta-study conducted in 2010 concluded there is a lack of concrete evidence associating mental health and green space despite a number of previously published studies (Lee and Maheswaran, 2010). The researchers reviewed studies published after 1990 with a specific focus on green or public

open spaces as they relate to human health. This was done in an attempt to develop a “narrative summary for health policy-makers and urban planners” (Lee and Maheswaran, 2010: 212). This meta-study found a range of results such as strong support for the claim that green space offers increased opportunity for exercise, which in turn improves residents’ physical health. As for the connection between mental health and green space, these studies tend to rely on qualitative reports rather than quantitative studies. Positive correlations between green space and social capital, sense of safety, and reduced stress were presented and discussed. These correlations were found to be generally consistent across the reviewed studies despite different locations and measurement tools used by researchers.

Green space has been found both to reduce stress and anxiety associated with negative mental health and also to add positive mental benefits to those who interact with it (Van Den Berg et al., 2010). Studies have shown that nearness and interaction with green space can reduce symptoms of anxiety and depression and improve recovery from mental fatigue (Pearson and Craig, 2014). Researchers who looked at individuals moving to greener and less green urban areas found that “sustained mental health improvements” (Van Den Berg et al., 2010: 1247) were associated with individuals who moved to urban areas that were greener than their previous neighborhoods (Alcock, 2014). A study of Dutch residents found that the presence of green space in communities can mitigate both the physical and mental negative effects that stressful life events have on individuals (Van Den Berg et al., 2010). Exercise done in green space has been found to result in higher ratings of mental well-being than similar activity conducted in an indoor environment (Coon et al., 2011).

While some relationships between MWB and green space have been found, the meta-study discussed earlier confirms that current evidence and conclusions in this area of research are still weak at best (White et al., 2013; Lee and Maheswaran, 2010).

In recent years, another, lesser-known type of space called “blue space” is capturing the attention of researchers who believe that it may have benefits similar to that of green space. One study looked at how the health of English residents related to their residential proximity to water. The researchers found that as distance to the coast decreased, overall health increased (Smedley, 2013). Results from this study indicated that other water features also positively affect health. A plausible explanation for this relationship focuses on the fact that humans “evolved in intimate contact with nature, and it is only really in the last 200 years that people have been increasingly removed from nature “ (2013). Humans may have an innate desire to be near water: “There is something deeply profound about water and humans, and it may reflect evolutionary history”, marine biologist Alister Hardy has said (2013). Human attraction to water may relate back to and be an extension of the biophilia hypothesis (Wilson, 1984).

Further, Karmanov and Hamel (2008) found that blue space in urban and natural contexts is associated with multiple positive effects including mood enhancement, stress reduction, and expansion of mental attention. The range of recreational, restorative and spiritual benefits of blue space have been documented on an individual and personal level (Völker and Kistemann, 2011). In a study published in 2010 participants were shown a range of

120 photos with a mix of green, blue, and built space and their reactions to the images were recorded. The researchers found that blue space in natural and built environments produced more positive subjective reactions from individuals than similar areas without water features (White et al., 2010).

Volker and Kistemann (2011) looked at literature relevant to blue space and well-being, ultimately including 36 studies published after 1981. Across the studies, views of landscapes containing water were consistently reported as “positive, attractive, and fascinating” with the existence of water features being “a strong predictor of preference for landscapes in general”. This preference exists due to blue space’s potential to offer refreshing, calming and energizing effects (Volker and Kistemann, 2011; White et al., 2010). The review also points out fascinating spiritual and emotional reactions by individuals in response to the presence of water in their landscapes. Studies also exist that quantitatively support the notion that humans prefer environments with water such as a 2000 study that used a hedonic model to show that house prices near water tend to be higher than those not near water (Luttik, 2000). As a relatively new field of inquiry, blue space may have intuitive and encouraging benefits for all but there is a noticeable lack of research addressing the effect of water on urban dwellers (Luttik, 2000).

Walkability of a neighborhood, in addition to green and blue space, may also affect the MWB of its residents. Walkability refers to the ways in which the built environment enables pedestrian activities. In the past decade, walkability has received increased attention in regards to its relationship to human health. Andrews et al. (2012) note “an initial scan of

the literature published in *Social Science & Medicine* and its sister journal *Health & Place* found more than forty papers that focus exclusively on walkability”. A number of these studies looked at the connection between mental health and walkable areas and found that pedestrian activities, facilitated by improved walkability of neighborhoods, provide means for residents to experience a range of positive emotions, including higher self-confidence and other therapeutic, spiritual and escapeful feelings.

Like blue space, research into the benefits of walkable neighborhoods is an emerging field that still has limited conclusions but has experienced immense growth in recent years (Florida, 2011). Cities and neighborhoods with high levels of walkability have been shown to foster high levels of social capital and contribute to physically healthy and more emotionally relaxed residents (Abraham et al., 2009).

In one study, researchers found specific benefits of exercise for people 65 and older including better quality sleep, delayed onset of many diseases, improved perception of life condition, and positive effects on cognition (Sugiyama and Thompson, 2007). In addition to encouraging more physical activity, walkable areas have also been associated with higher levels of civic engagement and social capital, better cognitive health of residents, and crime reduction in communities (Florida, 2014).

Scales that assess and measure the walkability of an area may take into account a wide range of factors to generate a true measurement of the walkability of a specific address or

general area. Common techniques used to evaluate walkability are presented in the discussion.

Though there are a number of studies exploring the positive mental benefits associated with high levels of a neighborhood's green space, blue space, and walkability, much of this research has been conducted in European countries. Studies focused on the urban Midwest are far less common (Karmanov and Hamel, 2008; Lee and Maheswaran, 2010; Abraham et al., 2009). As such, this study looks at MWB scores and built environment characteristics to explore if and how these hypothesized relationships are present in neighborhoods of Columbus.

Methods

The process of collecting data for this study can be split into three parts. Collecting information regarding the dependent variable, the independent variables and the control variables was done in separate ways.

I. Dependent variable: Mental Well-Being

Data for the dependent variable of this study, the multi-dimensional measure of mental well-being, was collected during Fall 2015 and January 2016. The data comes from a survey designed for a broader study exploring the relationship between consumption, environmental impacts, and well-being.

Phase one of data collection involved developing a well-being metric for the city of Columbus. It has been suggested that a context specific measurement of well-being should be used in the collection and calculation of well-being scores in a particular area (Corvalan et al., 2005). The metric used in this study was derived from feedback gathered from Columbus residents through two interactive processes. Researchers used focus groups and “street stalls” to engage with residents to determine the extent to which certain factors, derived from the Oxfam Humankind Index, contribute to overall well-being (Walker et al., 2012). An example of the activity done at street stalls, where participants ranked the importance of 19 different components of well-being, can be seen in Appendix A.

Feedback from Columbus residents resulted in a final list of 26 factors, which were categorized into several categories; one category included any factors that measured an aspect of the mental health of individuals. The primary dependent variable used for this study is an index of these five WB factors that relate specifically to mental health. In addition, a secondary analysis used a single component of this index (happiness).

Phase Two of data collection was a survey conducted in two neighborhoods of Columbus. Clintonville and Olde Towne East were chosen to explore variation in their green space, blue space, and walkability as well as for their socio-economic characteristics (see below). Within each neighborhood, six territories were selected based on boundaries of US census blocks.

The “drop-off, pick-up” (DOPU) method was used to distribute surveys to households on three randomly selected streets in each of the six territories of both neighborhoods. This method was used because it has been found to have a higher response rate than standard mail surveys and because of the clustering of households in the territories targeted by the study. In addition DOPU has been found to “offer promise for reducing non-coverage error and possible sample bias without sacrificing response rates (Steel et al., 2001).

Researchers aimed to maximize contact with those surveyed by initially only dropping surveys off at houses where residents answered the door. Respondents were informed of the general nature of the study and the importance of accurately filling out the surveys to the best of their ability. Surveys were expected to take between 15 and 20 minutes and respondents were informed that researchers would return in several days to pick up completed surveys that could be left hanging on the door in the provided bag. On survey visits the researchers also informed participants of an online option to complete their surveys. Each of the three streets in each territory was ultimately visited four times in order to gather adequate responses and give multiple chances for a response. After the fourth visit, surveys were left at all households for which there was at least one attempt to contact the resident (up to 75 households per territory).

The survey contained questions related to environmental behaviors, well-being, and demographics. The well-being portion of the survey included the previously mentioned 26 factors for respondents to rate themselves on. The factors were presented as statements and respondents were asked to rate themselves on a scale of 1-7 (1=strongly disagree,

7=strongly agree). MWB data was collected from survey results of 271 individuals across all surveyed territories.

An algorithm was developed to combine the metric developed from Columbus resident feedback in Phase One and the self-ratings collected from Phase Two. The data from phase one was used to assign a weighting for each component of well-being based on the average ranking it received from participants. As such, each factor was assigned a multiplier between .16 and 1.5 to indicate how important the factor is as a contributor to Columbus resident well-being. In addition, this weighting varied by age group to reflect the likelihood that the factors that contribute most to well-being change through one's life cycle (see table 1). The additional factors that were added after Phase One were assigned a neutral value of .79 (the average for the 19 components included in that study). The multiplier was then applied to each respondents' self-reported scores and summed to calculate a final mental well-being value for each territory (see Appendix B). The five factors that relate to mental well-being and their weights are shown in Table 1.

Table 1. Mental well-being factors and their weights

Factor	Weight per age group
On an average day, I feel mentally happy (happiness)	Age 18-30: 1.07 Age 31-45: 1.07 Age 46-60: 0.74 Age 61-88: 1.09
I enjoy my leisure time	

(leis.time)	Age 18-30: 1.07 Age 31-45: 1.13 Age 46-60: 0.87 Age 61-88: 0.75
I have good spiritual health* (spir.hlth)	Age 18-30: 0.79 Age 31-45: 0.79 Age 46-60: 0.79 Age 61-88: 0.79
I am positive about my future* (pos.future)	Age 18-30: 0.79 Age 31-45: 0.79 Age 46-60: 0.79 Age 61-88: 0.79
I feel good about myself and my life (feel.good)	Age 18-30: 1.02 Age 31-45: 0.65 Age 46-60: 0.74 Age 61-88: 0.89

*= one of seven factors added after feedback and responses from Phase One of data collection

Study Sites

Because the two neighborhoods studied in Columbus do not have distinct geographic boundaries, two zip codes were associated with each of the neighborhoods and the limits of these zip codes were used to define the neighborhoods. Clintonville (43214 and 43202) is regarded as a prestigious neighborhood of Columbus, while Olde Towne East (43202 and 43205) has a less prestigious reputation. Clintonville has been experiencing rising housing prices in recent years while Olde Towne East continues to see high rates of vacancy. Both have similar accessibility to Columbus' downtown and are within the 270 outerbelt. In

terms of demographics, Clintonville is largely white (91% “white alone”) while Olde Towne East has a much more mixed demographic makeup (60% “white alone”) (U.S. Census, 2010). Clintonville has a higher median income (\$53,112) and less variance than Olde Towne East, which has a lower median income (\$35,499) and a larger diversity of income levels. Block groups were chosen within these two neighborhoods based on census data from 2010 to ensure that there was demographic variation (specifically median household income and race) between the block groups. Six block groups were chosen in each neighborhood to make a total of twelve block groups. These twelve block groups are referred to as “territories” throughout the study. Finally, three streets per block group were randomly chosen. The territories’ locations and sizes, as well as the specific streets surveyed can be seen in Figure 1

II. Independent Variables

In order to generate and organize the data relevant to the twelve territories and their green space, blue space, and walkability (the independent variables), QGIS and Excel were used extensively. Ultimately four distinct independent variables were defined: green space acreage, percentage green space, sidewalk length, and percentage blue space. The values for these amenities were calculated for each of the twelve territories and are summarized in table 2.

Green space acreage refers to the number of acres of green space within or intersecting a territory’s one-mile buffer zone. Percentage green space is the amount of space (in acres) in

a territory's one-mile buffer zone divided by the total acreage of that zone (zones differed in size because of small differences in territory size). Sidewalk was calculated by measuring distance of sidewalk within a territory's one-mile buffer zone in miles. Blue space was defined as any point that was within a one-mile distance of a main water feature. Percentage blue space was acreage within a territory's one-mile buffer zone that was "blue" divided by the total acreage of that zone.

To begin data collection, publicly accessible files from the Mid-Ohio Regional Planning Commission (MORPC) were used to map out green space. The file used contains spatial information of golf courses, cemeteries and parks in and around Columbus. Figure 1 shows the base layers for work that was done in QGIS. Territories in the top left corner are Clintonville 1-6 and the territories in the bottom left are Olde Towne East 1-6. This map also contains MORPC's open space data (dark green areas), a sidewalk inventory (with those actually used for surveying purposes highlighted in white), and the major relevant rivers and tributaries throughout the area.

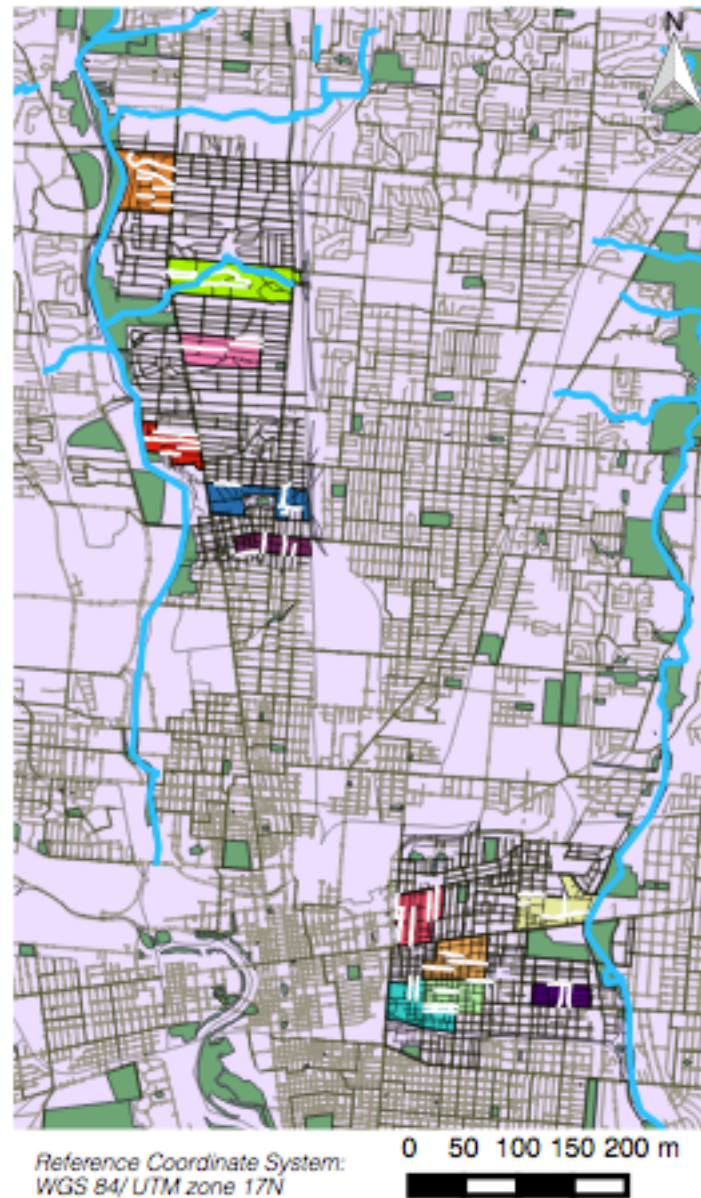


Figure 1. QGIS map of the 12 territories studied and their associated green space, sidewalk and water features with surveyed streets highlighted in white

For each territory I calculated the percentage of green space within a one-mile radius around the perimeter of each territory. The analysis was performed in QGIS. A one-mile buffer was drawn outward from the perimeter of each of the twelve territories because,

although the distance people are willing to walk varies by person and by trip, studies have found that pedestrians walk much farther distances when the destination or purpose is for leisure or recreation (Yang and Diez-Roux, 2013). The distance of one-mile was chosen because it is estimated to be a good representation of how far people are willing to walk in order to access green space (Iacono et al., 2008, Donahue, 2011).

Once the buffers were created the green spaces “intersecting” or “contained” by the one-mile buffer layer were selected individually for each territory. Green spaces that were within the layer were classified as “accessible”, as well those that intersect the one-mile buffer, because it was assumed that if residents could access any part of a green space, then that entire space was accessible. Figure 2 shows Clintonville 6 (orange), its one-mile buffer zone, and the green space that is within or intersecting the one-mile buffer (highlighted dark blue areas).



Figure 2. Clintonville 6 territory, one-mile buffer zone, and associated green space

The acreage of each buffered area was calculated and the basic statistics analysis tool was utilized to convert units and calculate the total green space within the buffer zone. Finally, the acreage of green space within or intersecting the zone was divided by the total acreage of the zone, resulting in a green space percentage associated with that territory.

To measure blue space, a one-mile zone was used again to determine how much of the territory's area is within a one-mile distance to a river or tributary (spatial information on water features obtained from the USGS National Hydrography Dataset, 2011). Then, the geoprocessing tool in QGIS was used to create an algorithm to select only features that

overlapped between the one-mile buffered individual territory layer and the new water buffer layer. An example of the blue space associated with a territory can be seen in Figure 3. Finally, the acreage of blue space in the territory was divided by the territory's total acreage to get percentage blue space within the territory's buffer zone.

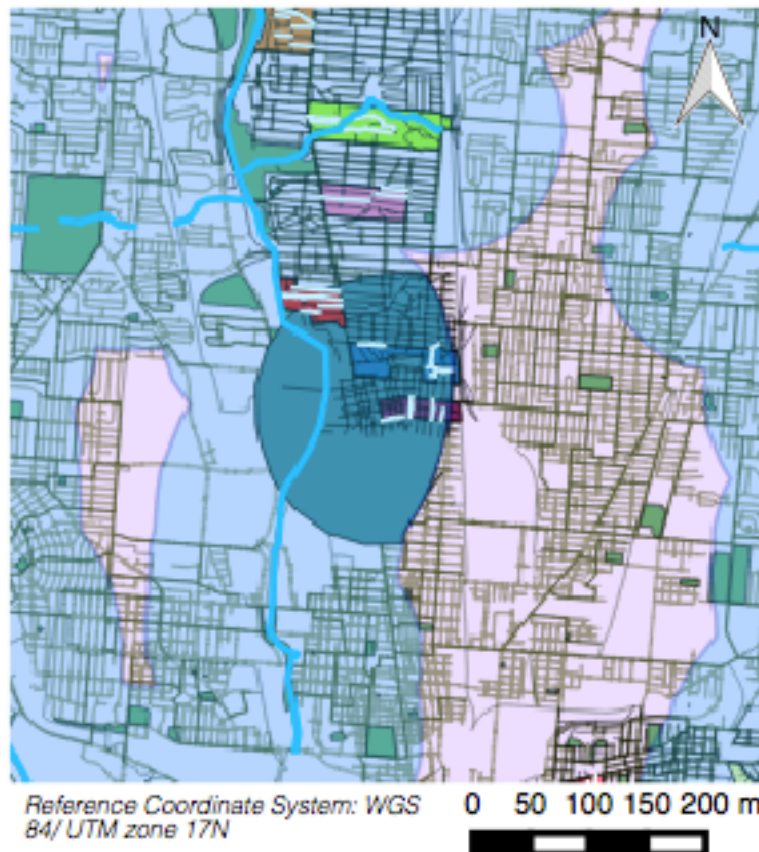


Figure 3. Clintonville 1 (dark purple territory) shown with the blue space layer enacted (light blue) and the portion of Clintonville 1's one-mile buffer zone that overlaps with blue space (teal)

To measure walkability, I calculated the distance of sidewalk within the one-mile buffer area. Within QGIS, the select by location algorithm was used to select and sum the length of sidewalks (in miles) that were contained within the territory's buffer zone (Figure 4).

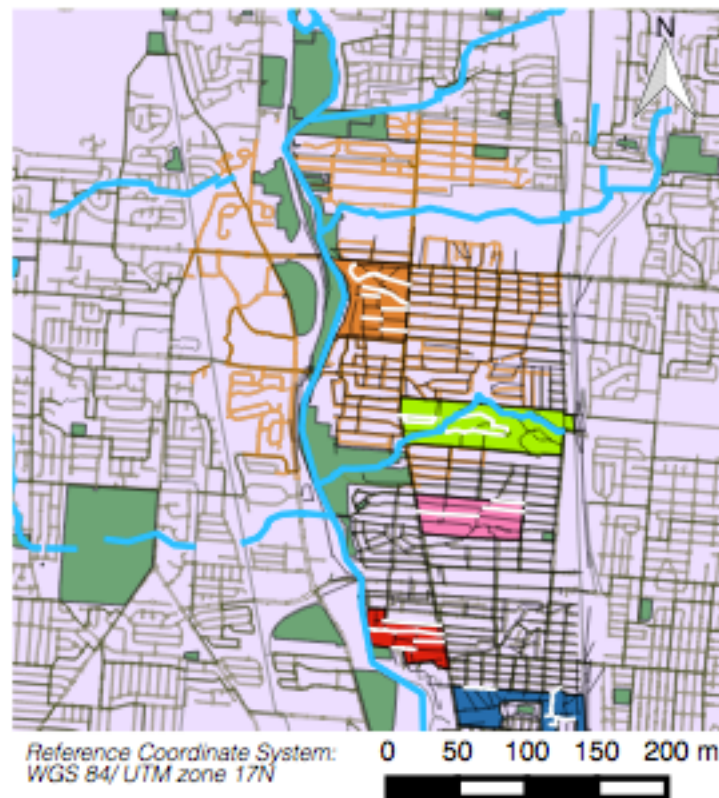


Figure 4. Sidewalk length (highlighted in orange) used to calculate walkability for
Clintonville 6

Once amenity values were drawn from QGIS, the data was compiled in excel and converted into proper units. The data for each territory is summarized in Table 2.

Table 2. Summary of physical amenity data per territory

Territory	Green Space Acreage	% Green Space within 1 mile buffer	Sidewalk Length in miles	% Blue Space within 1 mile buffer
CV1	228.41	7.46%	136.99	56.40%
CV2	230.12	6.41%	164.74	62.71%
CV3	359.95	11.67%	125.59	95.42%
CV4	316.88	9.62%	145.58	91.83%
CV5	285.2	7.13%	169.06	94.95%
CV6	565.48	16.24%	113.33	100.00%
OTE1	119.25	3.81%	163.03	20.36%
OTE2	210.32	6.54%	185.26	36.85%
OTE3	164.25	5.42%	192.81	34.26%
OTE4	129.48	3.96%	223.81	20.37%
OTE5	277.22	9.55%	154.83	77.83%
OTE6	252.68	7.35%	165.67	73.61%

III. Control Variables

I controlled for race, gender, income, and level of education based on responses to survey questions. Race, gender, income, and level of education were all measured as categorical variables. Racial/ethnic categories were taken directly from the most recent U.S. Census

survey (2010). To reduce the number of categories in the regression analysis, these racial and ethnic categories were further grouped into one of two categories: “white” or “non-white”. Those of Hispanic ethnicity were also considered non-white (though, it is recognized that Hispanics are often times considered white in their racial identity). This categorization was ultimately a dummy variable separating non-minorities (non-Hispanic whites) and minorities (all other racial/ethnic groups). Gender was broken down into three categories: male, female, or other. No respondents answered “other”, so analysis was based on the remaining two categories. Household income levels were broken down into eight categories, in ranges of \$20,000, spanning from “<\$20,000” to “>\$140,000”. There was also an option of “don’t know” for those who were uncertain. Education was broken down into six categories: some schooling but no diploma or degree, high school diploma or GED equivalent, some college, college degree, some graduate school, or graduate degree.

Analysis and Results

This analysis was conducted in the statistical program R, and the analysis proceeded in two steps. In the first step the relationship between MWB and each of the four amenity variables (green space acreage, percentage green space, percentage blue space, and walkability) was explored. A multilevel linear regression model was used to explore this relationship (see Table 3 for results). Multilevel modeling allows one to avoid statistical problems associated with a nested study design. For example, contextual factors, such as local social conditions, could influence individual-level of well-being. If this is the case, the assumption of independent errors is violated, which increases the risk of type I errors. To

account for potential non-independence of individual responses, multilevel models allow for variation at each level. For this analysis, I used two-level models having surveyed individuals (level one) within twelve territories (level two). These territories were then nested within neighborhoods, but multilevel models require more than two groupings and since we only have two neighborhoods, this level was controlled for using another dummy variable in the regression.

The control variables of income, gender, race, and level of education were included in the model; taking into account the effects of these variables helped establish a more robust representation of the interaction between the principal variables.

Table 3: Results of multilevel model regression for the mental health index

Predictor	Model 1 Estimate (S.E.)	Model 2 Estimate (S.E.)	Model 3 Estimate (S.E.)	Model 4 Estimate (S.E.)
Percentage green space (1 mile)	1.29 (2.31)	-	-	-
Green space acreage (1 mile)	-	0.00 (0.00)	-	-
Sidewalk (1 mile)	-	-	0.00 (0.00)	-

Percentage blue space (1 mile)	-	-	-	0.01 (0.00)**
Income (linear)	0.33 (0.10)**	.32 (0.10)**	0.33 (0.10)***	0.30 (0.10)**
Income (quadratic)	-0.07 (0.10)	-.07 (0.10)	0.07 (0.10)	-0.05 (0.10)
Gender (male)	0.04 (0.10)	.03 (0.10)	0.04 (0.10)	0.04 (0.10)
Education (linear)	0.20 (0.15)	.20 (0.14)	0.20 (0.15)	0.20 (0.14)
Education (quadratic)	-0.10 (0.11)	-.12 (0.12)	-0.12 (0.12)	-0.10 (0.12)
Race (white)	-0.38 (0.14)**	-.40 (0.14)**	-0.37 (0.14)**	-0.37 (0.14)**
Neighborhood	0.07 (0.16)	0.10 (0.16)	0.11 (0.19)	0.35 (0.17)*
Individual (residual)	0.59 (0.77)	0.59 (0.77)	0.59 (0.77)	0.58 (0.76)
Territory	0.00 (0.09)	0.01 (0.10)	0.01 (0.12)	0.00 (0.00)

.=p<.05

* = p<0.01

**= p<.001

***= p<0.00

There are several important results from these models. First, income and race are significantly associated with mental well-being. More specifically, higher income is associated with higher mental well-being and white respondents reported significantly higher well-being than non-white respondents. Second, of the four

amenity variables, only percentage blue space was significantly associated with higher mental well-being. The estimate for this variable (0.01) suggests that a one unit increase in a territory's percentage blue space is associated with a 0.01 unit increase in mental well-being. Percentage blue space in the twelve territories ranged from 20.36 – 100% and MWB ranged from 2 – 7. This result indicates that, all else being equal, a difference from 20% blue space to 100% blue space would lead to a $(0.01 \times 80) = 0.80$ increase in an individual's MWB score.

The second step of the analysis involved exploring the relationship between amenity data and the component of the average mental well-being score that may be most impacted by local environmental conditions. This factor, “happiness”, was measured with the question, “On an average day, I feel mentally happy”. I again fit multilevel model regression to each of the four amenity variables for the new dependent variable “happiness”, the results of which can be seen in Table 4.

Table 4. Results of multilevel model regression for single factor (happiness)

Predictor	Model 1 Estimate (S.E.)	Model 2 Estimate (S.E.)	Model 3 Estimate (S.E.)	Model 4 Estimate (S.E.)
Percentage green space (1	3.83 (2.42)	-	-	-

mile)				
Green space acreage (1 mile)	-	0.001 (0.00).	-	-
Sidewalk (1 mile)	-	-	0.00 (0.00)	-
Percentage blue space (1 mile)	-	-	-	0.01 (0.003)**
Income (linear)	0.37 (0.12)**	0.36 (0.12)**	0.39 (0.12)**	0.33 (0.12)**
Income (quadratic)	-0.03 (0.12)	-0.04 (0.12)	-0.02 (0.12)	-0.00 (0.12)
Gender (male)	0.07 (0.13)	0.07 (0.13)	0.07 (0.13)	0.09 (0.13)
Education (linear)	0.36 (0.18)*	0.36 (0.18)*	0.36 (0.18)*	0.33 (0.18).
Education (quadratic)	-0.11 (0.15)	-0.11 (0.15)	-0.12 (0.15)	-0.07 (0.15)
Race (white)	-0.54 (0.17)**	-0.55 (0.18)**	-.52 (0.17)**	-0.54 (0.17)**
Neighborhood	-0.02 (0.17)	0.01 (0.17)	0.06 (0.21)	0.33 (0.20)
Individual (residual)	0.90 (0.95)	0.90 (0.95)	0.90 (0.95)	0.87 (0.93)
Territory	0.00 (0.00)	0.00 (0.00)	0.00 (0.06)	0.00 (0.00)

.=p<.05

* = p<0.01

**= p<.001

***= $p < 0.00$

The first significant result came from Model 2, where the comparison between green space acreage and self-ratings of “happiness” resulted in an estimate of 0.001, which was significant at the $p < 0.05$ level. This finding suggests that an increase of one acre of green space in a territory’s one-mile buffer zone correlates with a 0.001 increase in an individual’s assessment of their own happiness. The green space acreage of territories ranged from 119.25 to 565.48 acres. This finding suggests that a difference of 446.23 acres is associated with a .45 increase in self-reported happiness.

The comparison to blue space resulted in a 0.01 estimate but at the $p < .001$ level, indicating that a one percent increase in blue space correlates with a 0.01 increase in self-reported happiness on the seven point scale. As percentage blue space associated within the territories had a range of 80%, this finding indicates that an 80% increase in blue space is associated with a $(.01 * 80 =)$.8 increase in happiness on the 1-7 scale.

Race and income were associated with “happiness” in all four models and education was also significantly and positively correlated with higher happiness scores in all four models.

Discussion

The key results from this study suggest that there is a positive relationship between blue space and the MWB of individuals. When “happiness” was compared to community amenity data, positive correlations between green space acreage and percentage blue space were also found. These results were significant and held after controlling for demographic

variables. Results from this study support prior research in this field that suggests a positive correlation between green space or blue space and mental health (Lee and Maheswaran, 2010; Volker and Kistemann, 2011).

Results may differ from those of prior studies (e.g. those that show a significant impact of walkability on MWB) due to differences in the well-being metric used and the methods used to collect data on the multiple components of well-being. Amenities were also measured in a way that differed from cited studies.

For instance, no significant relationship between sidewalk length and amenity values was found, perhaps due to sidewalk length being a weak estimation of an area's true walkability. Walkability scales differ in the number and type of factors that are included in an assessment. A stronger estimation of walkability of each of the territories may have been the Neighborhood Environmental Walkability Scale (NEWS), which "includes dimensions such as residential density, land-use mix, access to services, street pattern, availability of facilities for walking, aesthetics, and safety (Sugiyama and Thompson, 2007). The NEWS scale was not used because it requires responses to a 98 question survey, which were not included in the initial data collection process that took place before the conception of this study. In future studies, measurements of walkability should take into account not only the presence of sidewalks but also the length, quality and safety of those sidewalks as well their potential to function as a useful way to travel to desirable destinations.

Future Research

A study published in the *Journal of Social Science & Medicine*, expands upon one of the main reasons for slow research within the field (Araya et al., 2006). How the variables under consideration affect each other is a combination of complex interactions. As an example, the authors offer the example of a poorly cared for built environment, which negatively affects social cohesion in the community and leads to poor mental health. On the other hand, minimal social cohesion could result in a lack of care for the community environment, thus leading to lower reported mental health. The relationship and direction of these effects are complex and difficult to disentangle from other neighborhood aspects that also affect total well-being. The quantity and complication of all the factors that make up a community's physical amenities combined with the numerous factors that contribute to mental well-being has made progress in this field difficult. Controlling for extraneous and confounding variables and establishing a thorough and consistent measurement of MWB will be essential in future studies to reach conclusive results.

It should be noted that the overall study from which this data was collected was not initially created with the research questions of this study in mind. Survey results from the larger study were used because the well-being data was current, extensive, and relevant to this research. Future studies exploring mental well-being and its relationship to a community's physical surroundings should choose territories more strategically to control for social and economic factors and to maximize the diversity of physical surroundings associated with those territories.

Implications

Studies that further research in this field have wide implications for urban planning and design. More robust evidence is necessary because urban planning projects can be a significant financial endeavor, especially for small communities, and solid evidence of mental benefits can provide justification for change and investment. As more support is gathered relating MWB to green space, blue space, and walkability, high quality urban infrastructure such as parks, water features, and “complete streets” with landscaping buffers, traffic calming techniques, sidewalks, cross walks, and bike lanes may become more common.

Conclusion

Evidence from credible studies has shown repeatedly that contact with nature does contribute to improvements in human health (Maller et al., 2006). This study explored the impact of three physical amenities, with the most significant results coming from the exploration of a relationship between green space acreage and MWB and percentage blue space and MWB. Future studies will continue to make advancements in the field by incorporating characteristics (not merely the presence of) physical amenities into their studies. As has been repeatedly reported in the literature, “the effects of ‘green’ environments are increasingly well understood, [but] little is known about the importance of variation in the quality of greenspace for benefits to human well-being” (Fuller et al.,

2007). The quality, size, and shape of green space as well as the willingness of an individual to utilize the green space all change how it affects each person. Likewise, the quality and accessibility of the water, the optional recreational uses of it, and its connectivity to other water sources can all affect how beneficial a water feature is to a community.

The Oxford Journal of Public Health study previously mentioned (Lee and Maheswaran) acknowledges the need for further “robust evidence” within this field to generate a strong rationale urban planners can use to increase and improve green and blue space and to make our communities more walkable. Public open outdoor spaces can and should be designed consciously to provide the optimal area for social interaction and support, two community characteristics linked directly to mental health (Evans, 2003). Further credible quantitative research within this area of environmental psychology is essential for making more informed and beneficial policy decisions. Ultimately, advancement in this field of research will be relevant to the local government, as well as to design, architecture and planning firms. Developing a better understand of what matters to people and contributes to their happiness can influence policy decisions and encourage initiatives and infrastructure that effectively improve our communities.

Appendix A: Well-being activity hand-out at street stalls used to determine the relative significance of factors that contribute to well-being in Columbus, form A.

Please use these **15** sticky dots to rank the importance of the following **19** factors that contribute to well-being.

- Place each sticky dot *inside* the chosen factor's box.
- You can allocate as many sticky dots to one factor as you would like.
- Be aware that there are not enough sticky dots to rank every factor, so choose wisely!

Being able to easily access high-quality services	
Getting enough skills and education to live a good life	
Having good relationships with family and friends	
Having a say in what matters to you and feeling that your voice is heard	
Having a safe and secure home to live in	
Having confidence in yourself	
Having a secure source of money	
Being mentally well, not depressed or stressed	
Being part of a community	

Preserving the environment for the future	
Living in a neighborhood where you can enjoy going outside	
Feeling that you and those you care about are safe	
Having enough money to pay the bills and buy what you need	
Feeling good – having fun, being happy, etc.	
Having good transport to get to where you need to go	
Having satisfying work to do (whether paid or unpaid)	
Being physically healthy	
Having opportunities and the freedom to make your own choices	
Having a clean and healthy environment	

What is your zip code?

What neighborhood do you live in?

What is your age?

What is your gender?

- ☐ Female
- ☐ Male
- ☐ Other

Are you of Hispanic, Latino or Spanish origin?

- ☐ No, not of Hispanic, Latino, or Spanish origin
- ☐ Yes, Cuban
- ☐ Yes, Mexican, Mexican Am., Chicano
- ☐ Yes, Puerto Rican
- ☐ Yes, another Hispanic, Latino, or Spanish origin –
Print origin below (for example, Argentinean,
Colombian, Dominican, Nicaraguan, Salvadoran,
Spaniard, and so on.)

What is your race? Mark one or more boxes.

- ☐ White
- ☐ Black or African American
- ☐ American Indian or Alaska Native
- ☐ Asian Indian
- ☐ Chinese
- ☐ Japanese
- ☐ Korean
- ☐ Filipino
- ☐ Vietnamese
- ☐ Native Hawaiian
- ☐ Other Asian (please print below)
- ☐ Other Pacific Islander (please print below)

Please provide an email address **ONLY** if you would like to receive results of the study:

A

Appendix B: Example calculation of mental well-being scores

Each well-being score is a sum of individual factors where participants rated their own level of agreement on a 7pt Likert scale (i.e. from strongly disagree to strongly agree). Their score for each factor, between 1-7, was multiplied by the weight assigned to the factor based on their age. If they did not provide an age, an average of all weights was used.

For an 18-30 year old:

Single Factor score = Weight (Factor A score)

MWB = Weight (Factor A score) + Weight (Factor B score) ... + Weight (Factor n score)

Average MWB per territory = Sum of individual MWB scores of that territory/number of individuals in that territory

Sample calculation:

MWB of Individual 1 (27 year old, CV1):

$$(1.07*4)+(1.07*2)+(0.79*3)+(0.79*3)+(1.02*2)=13.2$$

$$\text{MWB of Individual 2 (65 year old, CV1): } (1.09*5)+(.75*4)+(.79*4)+(.79*3)+(.89*4)=17.54$$

Average for CV1 MWB: (Individual 1 MWB + Individual 2 MWB)/2

$$(13.2+17.54)/2=15.37$$

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